ECFA Calorimetry / Muon session summary

E. van der Kraaij (University of Bergen)

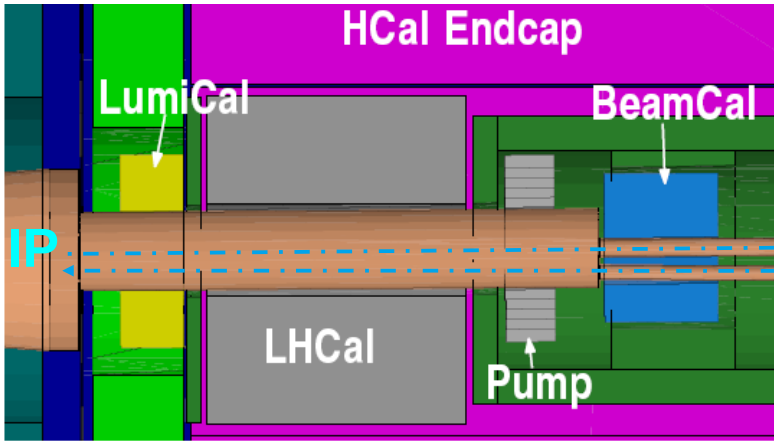
31 May 2013

Six sessions covering:

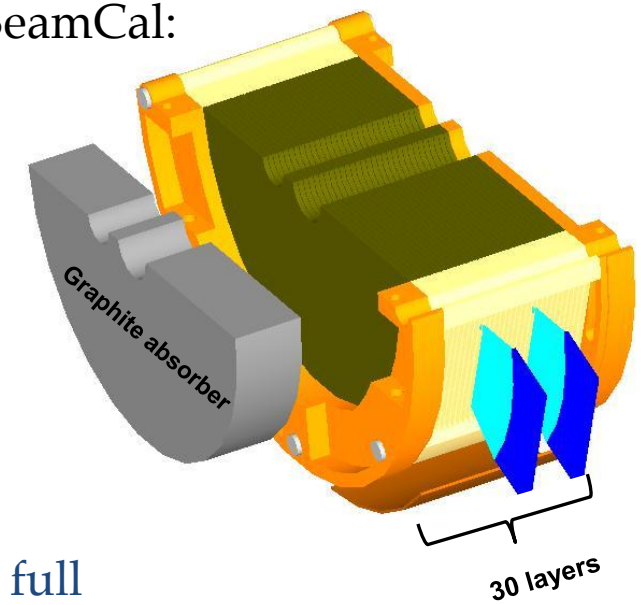
- FCAL: 5 presentations
- ECAL: 6 presentations
- AHCAL: 6 presentations
- DHCAL: 3 presentations
  One joint session with Tracking group covering MPGD R&D
- Muons: 1 presentation

BeamCal & LumiCal

Forward region:

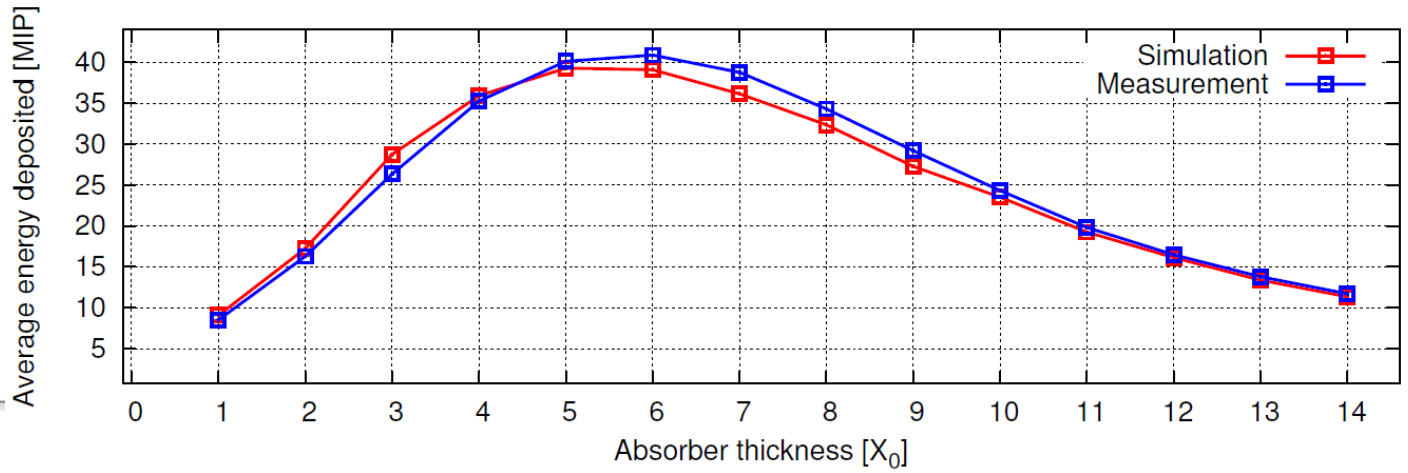


BeamCal:



For both detectors testbeams have positively checked full functionality of sensors, fanout, FE and DAQ.

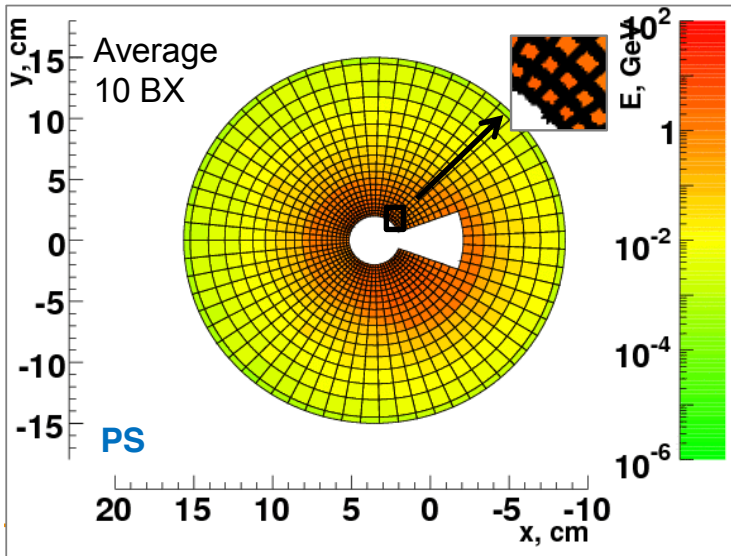
- MC simulations to compare with test results. Agreement with MC is found to be reasonable. Shower profile in LumiCal:



O. Novgoroda, I. Levy

FCAL ongoing R&D

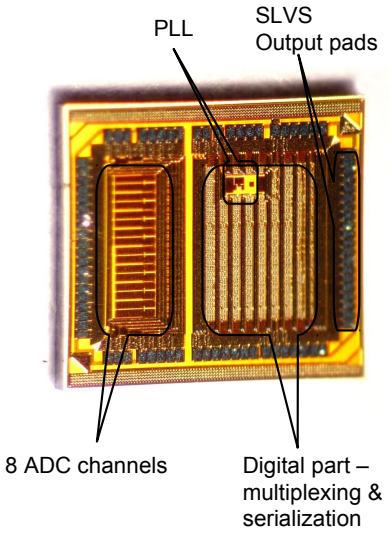
L. Bortko, J. Moroń



Simulation:

- Proportional segmentation for BeamCal improves the signal-to-noise ratio & reco eff.

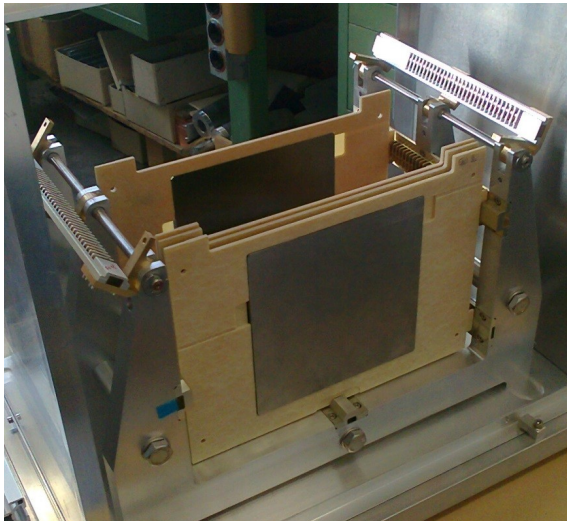
→ Localized high energy e^- can be identified easier out of broad / overall backgr distr.



← Development of new ASICs for LumiCal in 130 nm in progress

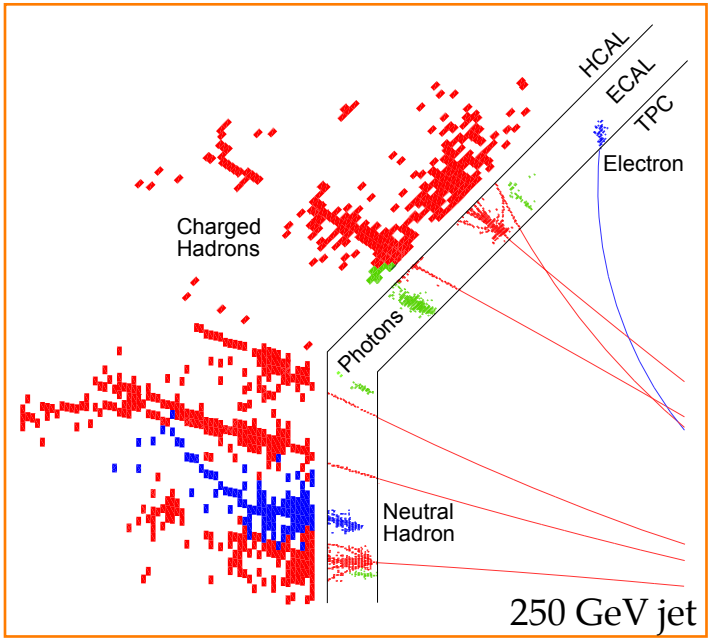
– First prototypes already in lab.

AIDA common infrastructure for future beamtests with 5 planes interleaved with tungsten

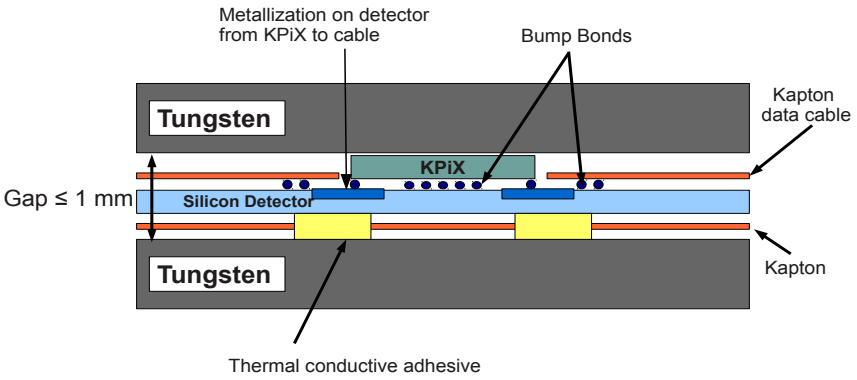


ECAL & HCAL → designed with PFA in mind

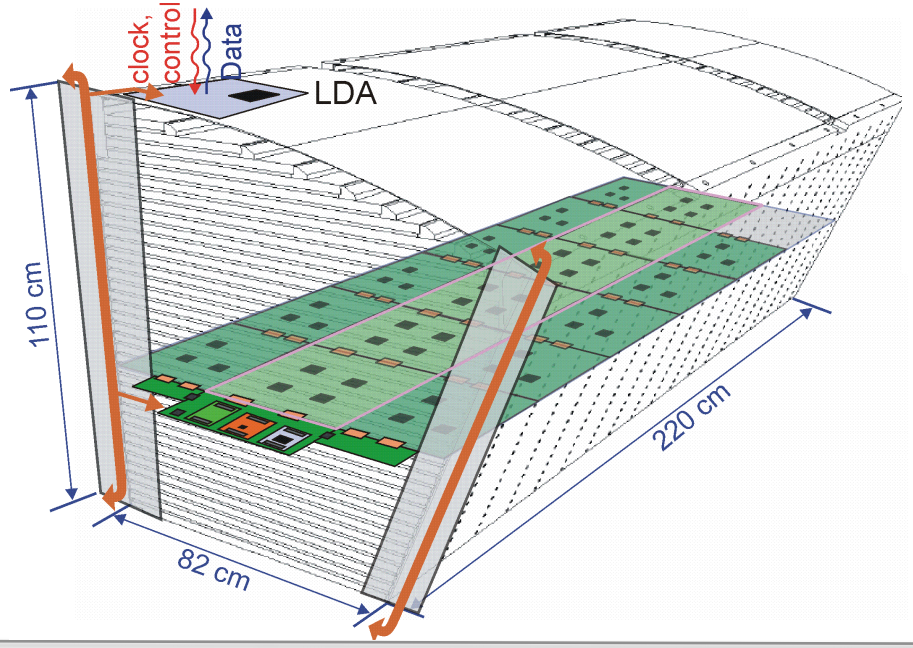
- Need calorimeters with very high granularity



Example – SiD SiECAL approach:

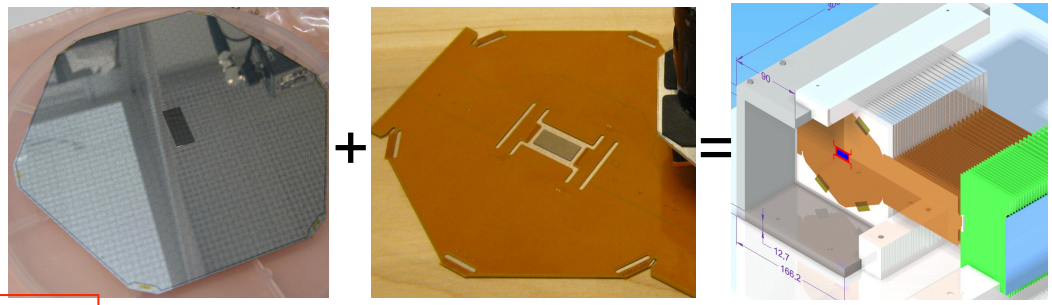


Example of HCAL module:



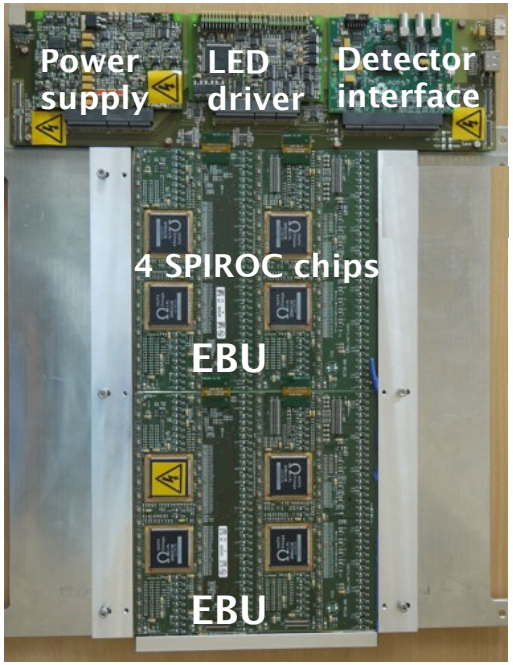
Silicon & Scintillator ECAL

- Silicon ECAL testbeam at SLAC
  - Prototype with ~ 15 cm diameter wafers
  - Initial run in July
  - Probably all 30 layers in '13/'14



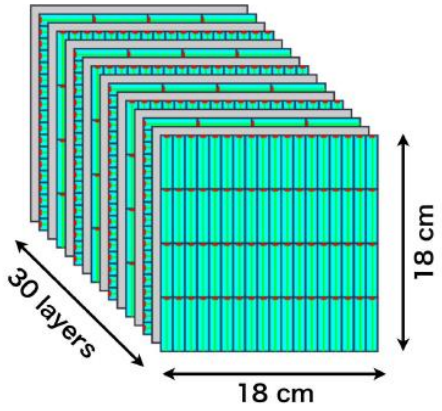
J. Brau

Total thickness per layer ~1 mm



T. Takeshita, Y. Sudo

Sensor thickness ~2 mm

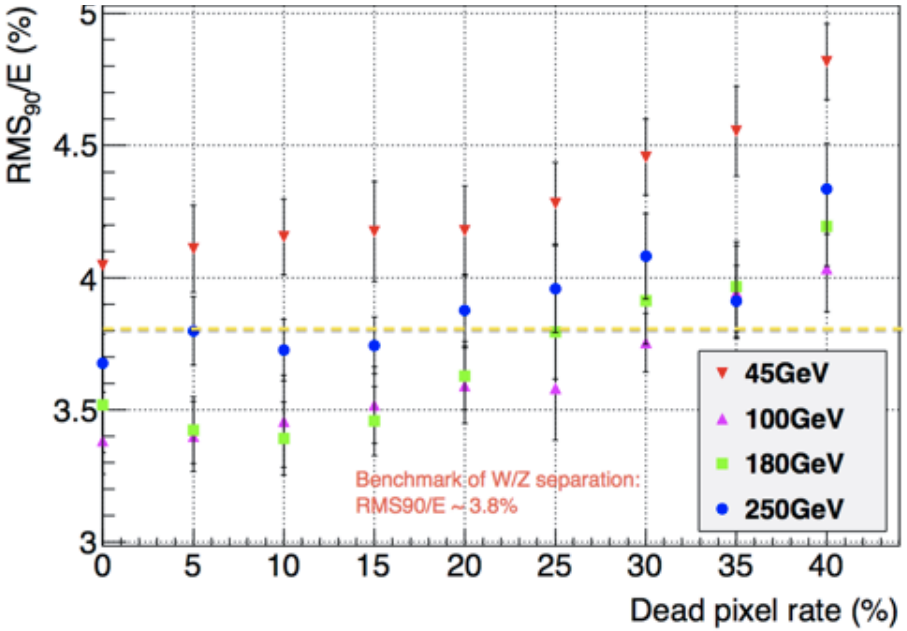


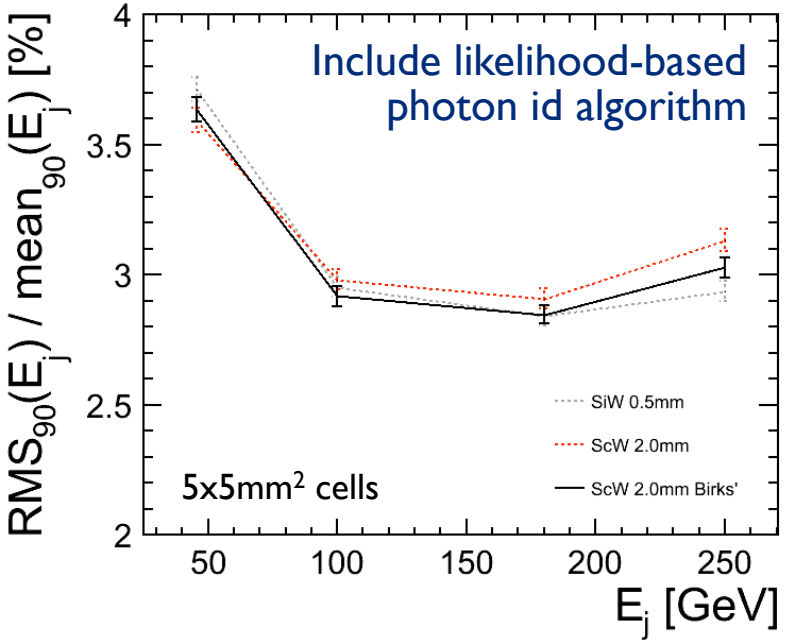
- Scintillator Ecal
  - From physics prototype to technological prototype.
- Outlook:
  - Beamtests of multilayered ScECAL in July
  - Possibly interleaved with SiECAL layers (=hybrid option)

ECAL simulation studies

C. Kozakai

- Studied effect of dead Si-ECAL channels
  - ➢ ECAL resolution is sensitive to dead channels but JER is basically limited by HCAL resolution.
  - ➢ Effective granularity is sufficient for PFA.





J. Marshall

← Adjusted PandoraPFA to cope with Scintillator ECAL

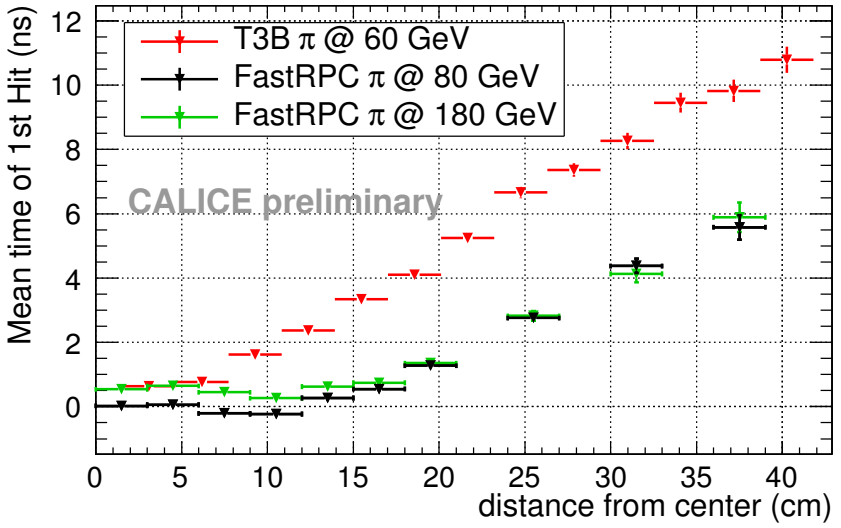
- Studying performances for pure Si-, Sc-, or hybrid ECALs.
- First results indicate similar performances.

Analog HCAL - results from physics prototypes

F. Simon

T3B - time development of showers:

- In an H-rich scintillator T3B experiment, the late arrival of neutron components is visible, compared to an H-poor RPC.

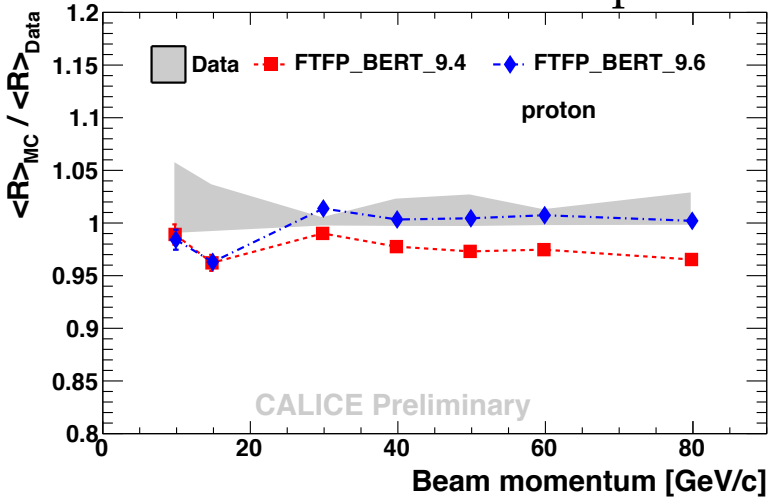


M. Chadeeva

AHCAL:

- Geant4 main production physics list is now FTFP-BERT
  - Significant improvement in going from Geant4 v9.4 to v9.6
- For some observables better agreement with CHIPS or QGSP-BERT

Example:
Mean shower radius for protons



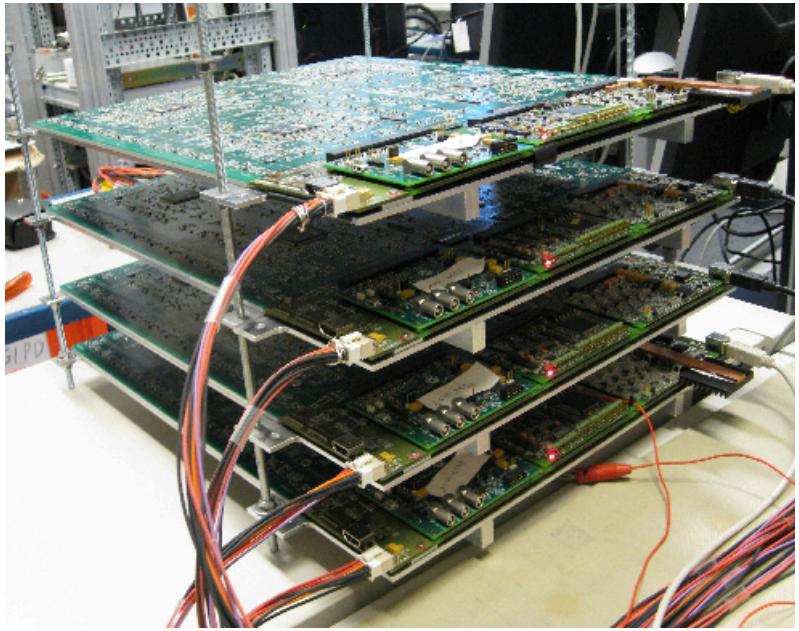
AHCAL - from physics to technological prototype

O. Hartbrich & S. Lu

Technological prototype with highly integrated ASIC for SiPM readout.

- Testbeam just started:
  - MIP calibration in air stack with 3GeV e+
  - Energy scans in Fe stack
- First DAQ stage is implemented
  - Data readout completely functional, 7x faster.
  - Next step: implementation of final DAQ architecture.

Scintillator tiles readout by SiPM sandwiched inside each layer:



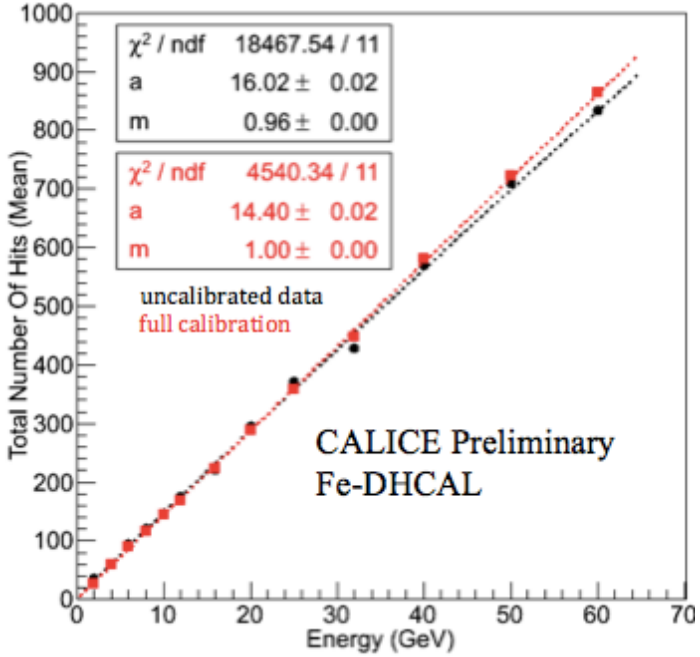
Digital and Semi digital HCAL

B. Bilki / I. Koletsou

- Smaller pads (1x1 cm^2), with no analog energy measurement per hit
  - DHCAL: 1 threshold
  - SDHCAL: 3 thresholds

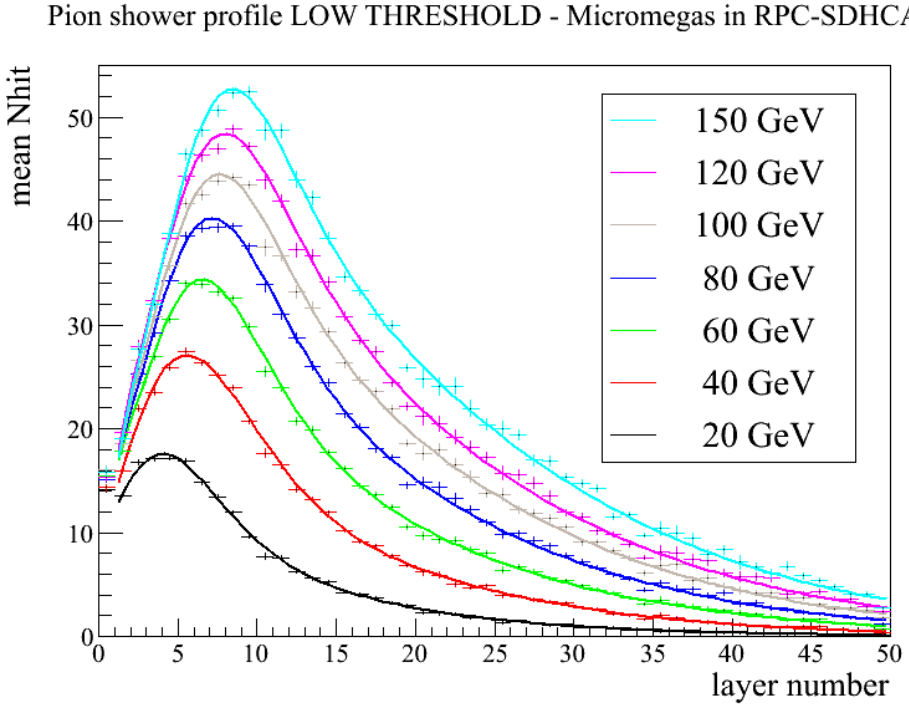
DHCAL testbeam report:

- Calibration more difficult than anticipated, but now under control.



SDHCAL tesbeam report:

- Impressive results from 4 MicroMegas planes distributed along RPC-SDHCAL.

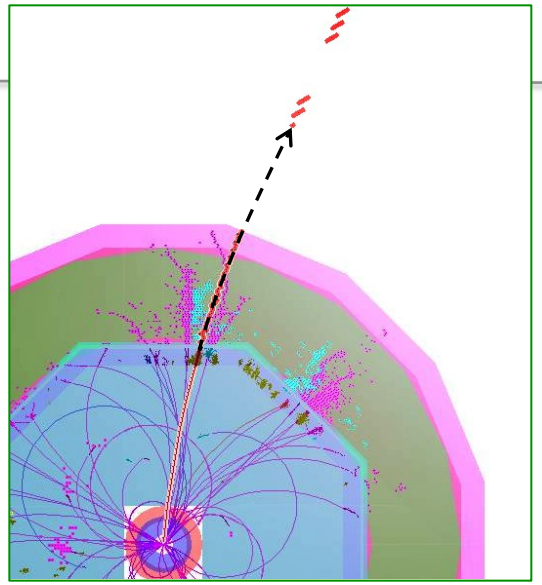


Conclusion

- Different concepts validated with physics prototypes
- Imaging calorimetry is feasible
- Next phase started: technological prototypes to work on technical and engineering details

Backup

Muon detector



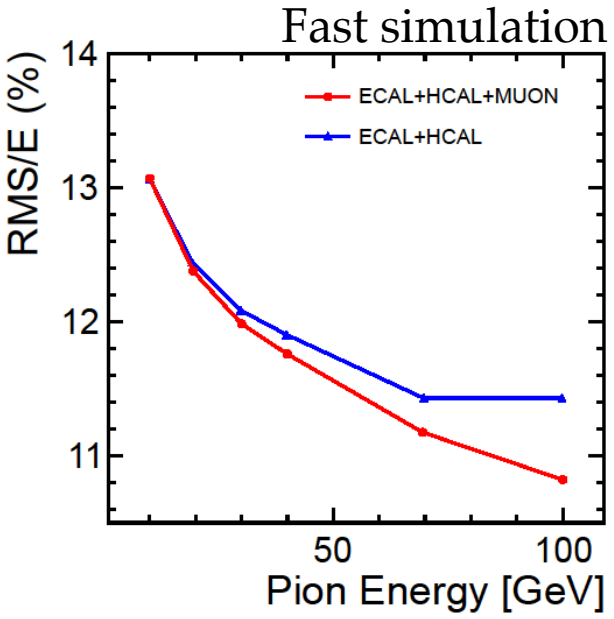
Muon identification

- ~97% muon identification efficiency
  ~99% pions rejection at energy >4 GeV
- Muons identification with energies < 4GeV:
  Needs dedicated analysis

- Multiple instrumented outer (thick) layers is useful for pion rejection.
- Increasing iron plate thickness from 10 to 20cm probably fine at low energies (low statistics so far), but significant degradation at high energies

Tail Catcher:

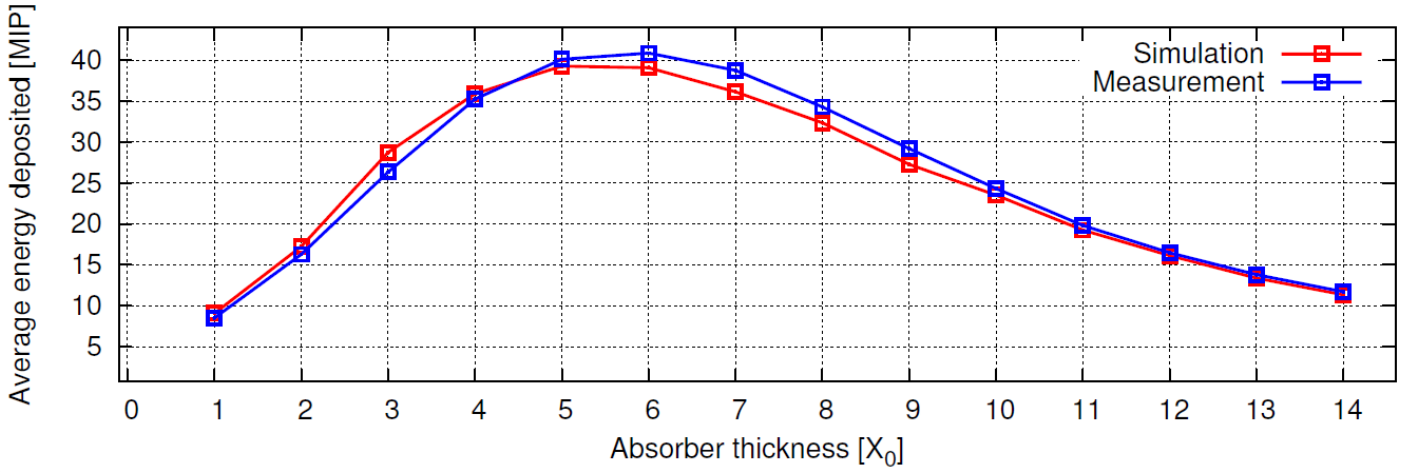
- Improves energy resolution, in particular at high energies



LumiCal beamtests

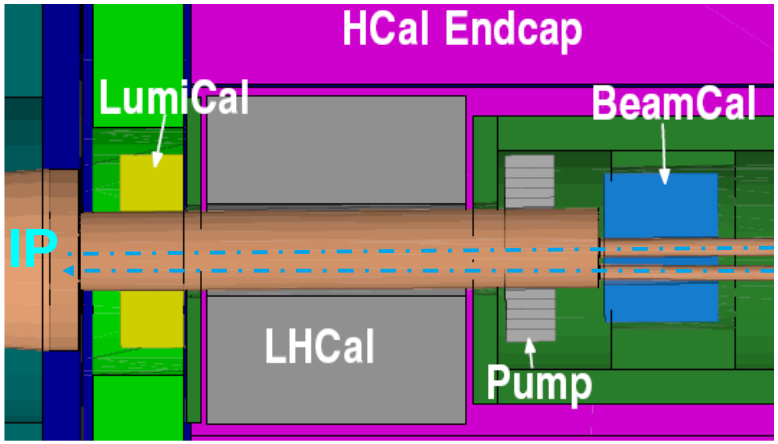
- In 2011 tests the complete detector module equipped with first level DAQ was tested.
  - Including the complete readout chain: Si-sensor, kapton fan-out, FE electronic.

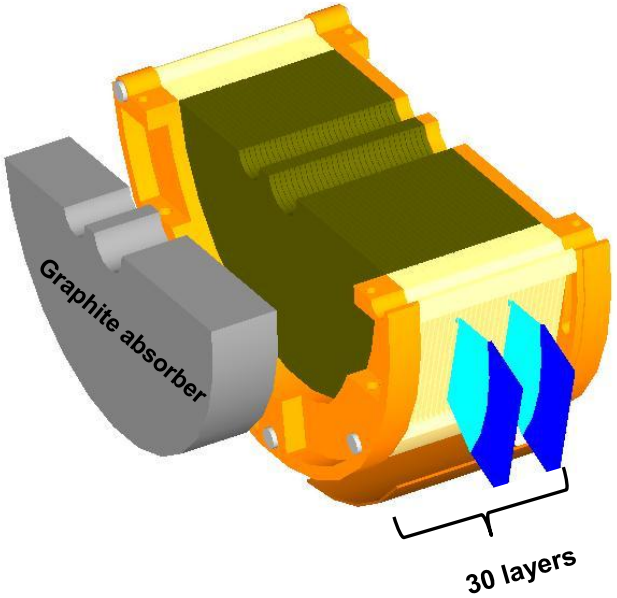
- MC simulations to compare with test results.
  - Shower maximum observed after six radiation length and agreement with MC is found to be reasonable.

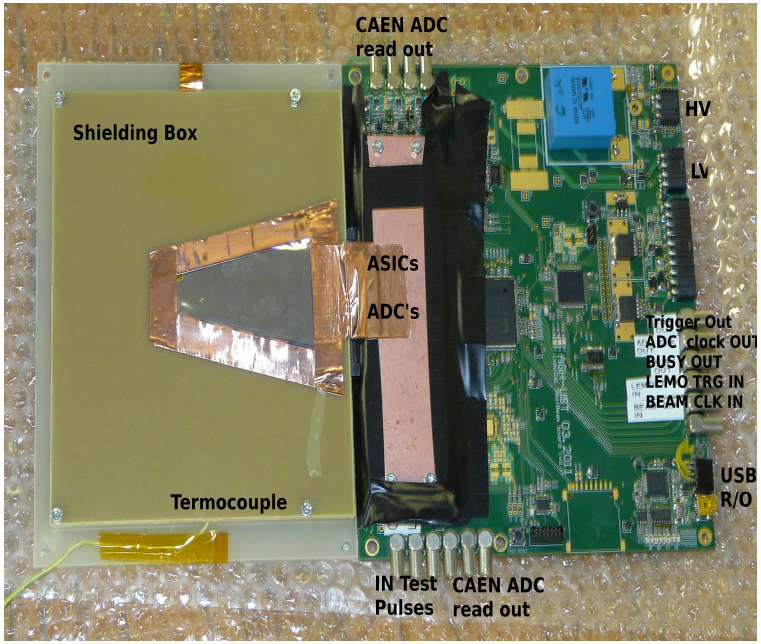


BeamCal & LumiCal

Forward region:







BeamCal: detect single high energy e^-

- Functionality of the chain: FE ASIC + ADC ASIC + fan-out + two sensor planes, checked on test beam (‘10-’11)

BeamCal – detector optimization

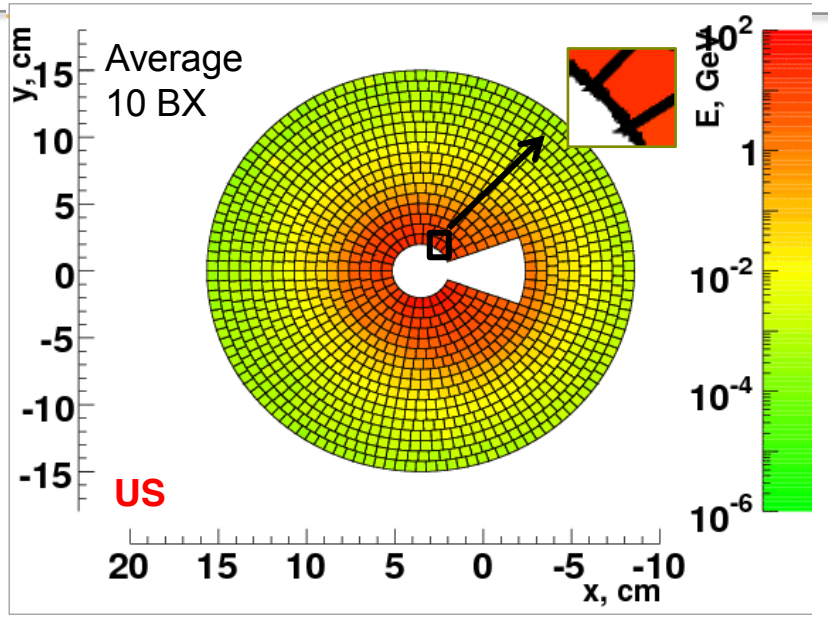
Performance of Beamcal for two different sensor segmentations was compared

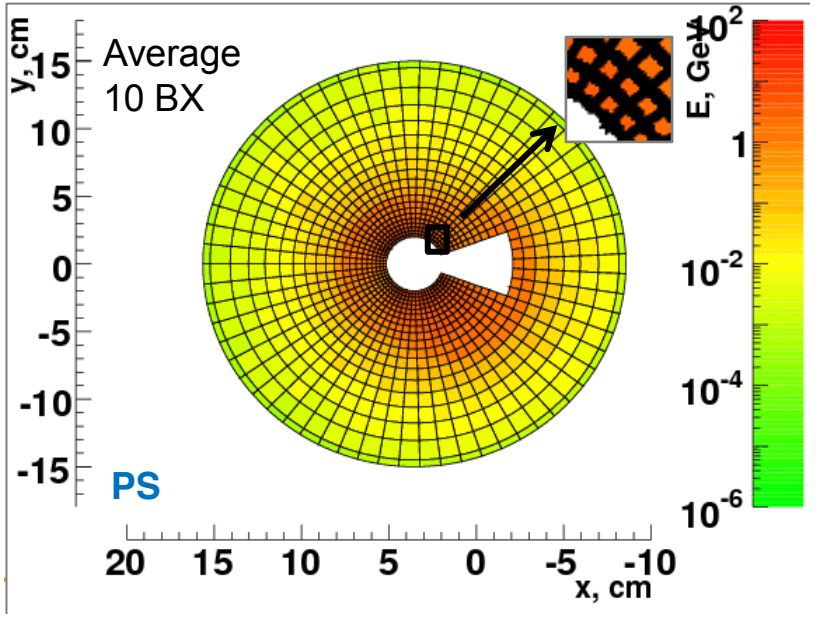
- Number of readout channels is kept similar
- Signal from sHEe nearly independent of the segmentation
- Energy deposition per pad from beamstrahlung differs significantly
- Proportional segmentation improves the signal-to-noise ratio
- Proportional segmentation gives better reconstruction efficiency

The charge range has been estimated

- Collected charge per pad from sHEe nearly independent of the segmentation
- Collected charge per pad from BS for US in 6 times more than for PS

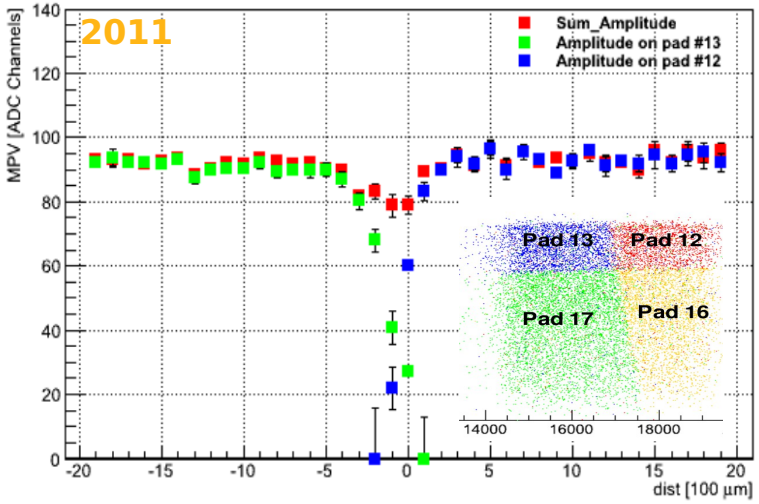
➔ Localized high energy e can be identified easier out of broad/overall backgr distr.

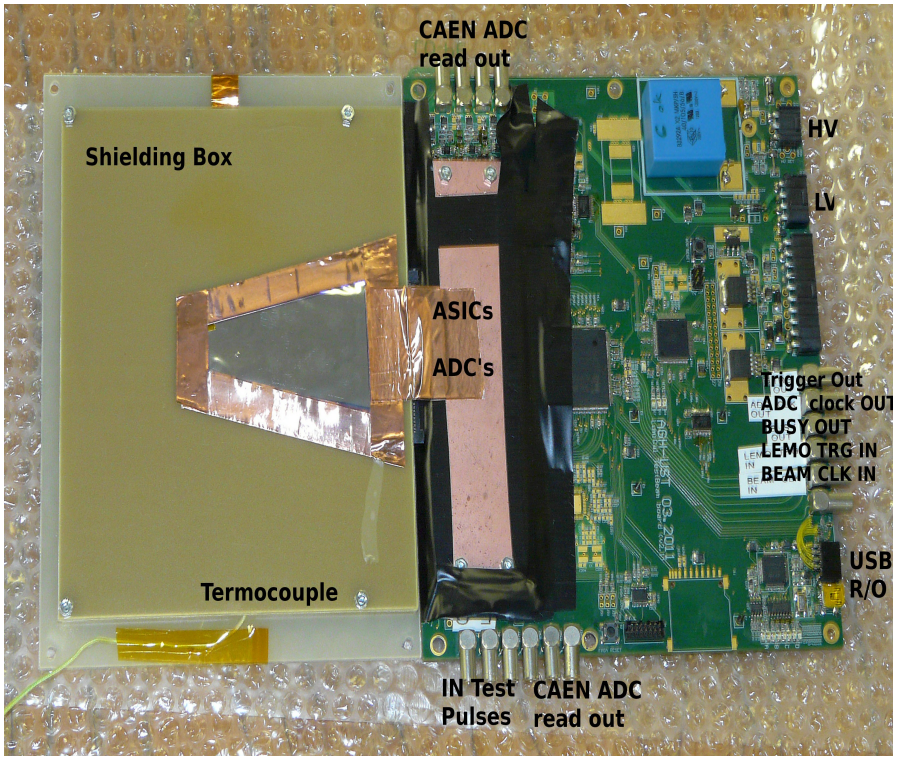


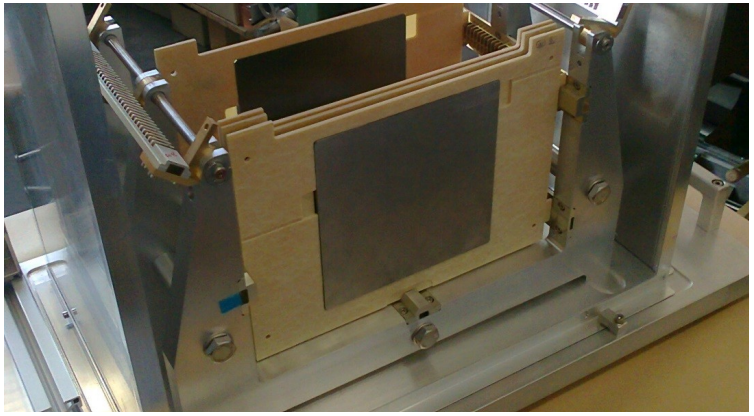


BeamCal - beamtests

- Two GaAs sensor planes were tested at the electron beam in 2010- 2011.
- – Functionality of the chain: FE ASIC + ADC ASIC + fan-out + sensors, positively verified on test beam
- Tracks are reconstructed from 3 telescope planes to DUT
  - Signal sum MPV of 2 pads shows decrease of only ~15% in 200um gap between pads.





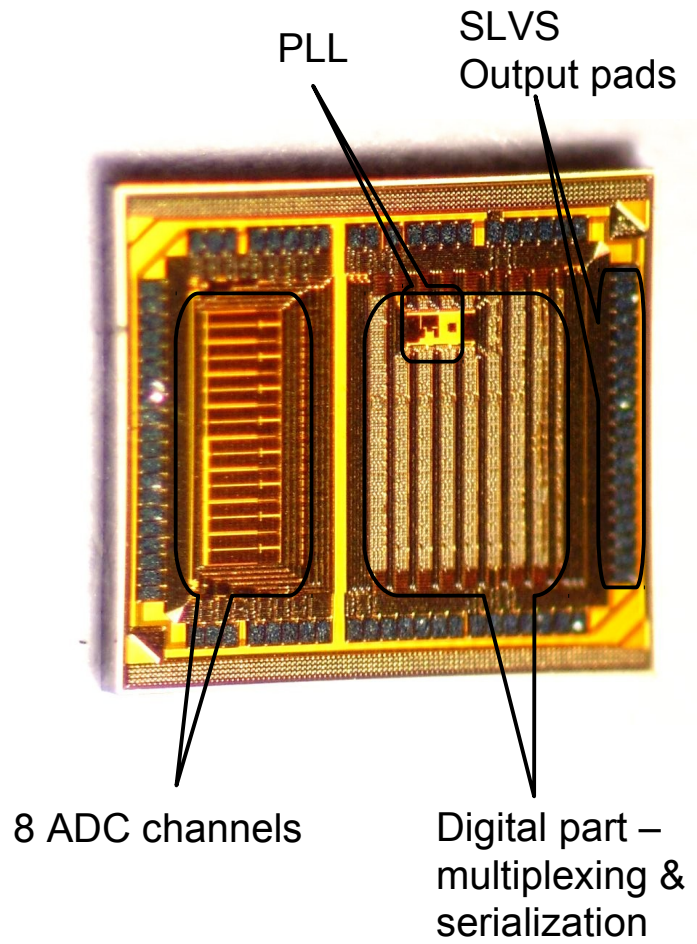


Future:

AIDA infrastructure + 5 FE Boards + 5 Sensors → Shower profile measurements → Comparison with GEANT4

LumiCal – electronics development

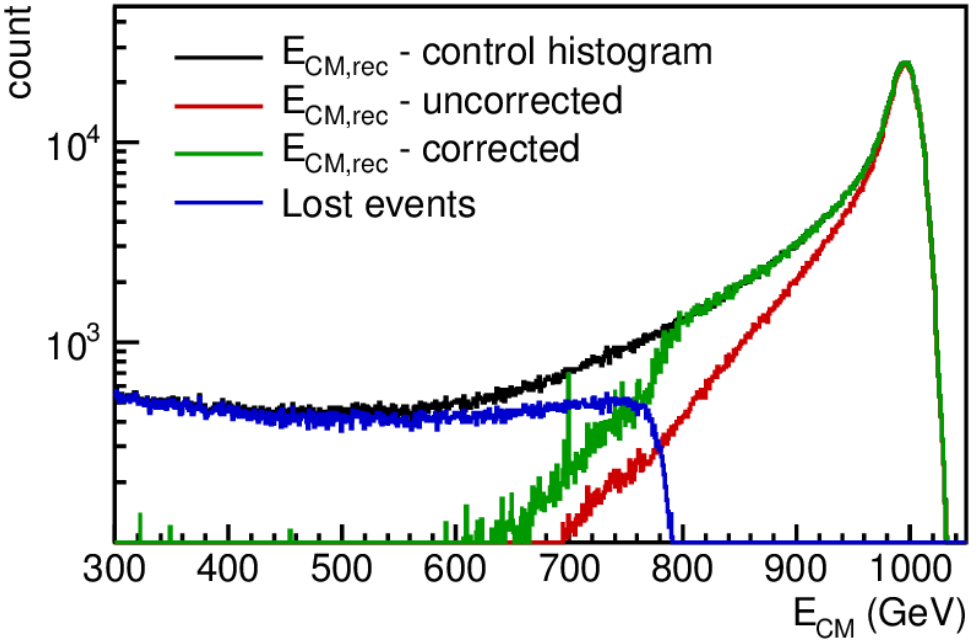
- Presently FCAL uses in test-beams the readout modules based on developed at AGH-UST ASICs in CMOS AMS 0.35um
- Development of new ASICs for LumiCal readout in IBM 130 nm in progress:
  - First prototype of front-end electronics submitted and should be available in ~June 2013
  - First prototypes of 10-bit SAR ADC, PLL, SLVS already produced and presently under test:
    - Includes powerpulsing and Successive Approximation Register SAR
  - 10-bit SAR ADC: first results show its functionality, the effective resolution slightly less than simulated - quantitative measurements in progress...
- – Depending on test progress and results we plan next submission at the turn of 2013/2014



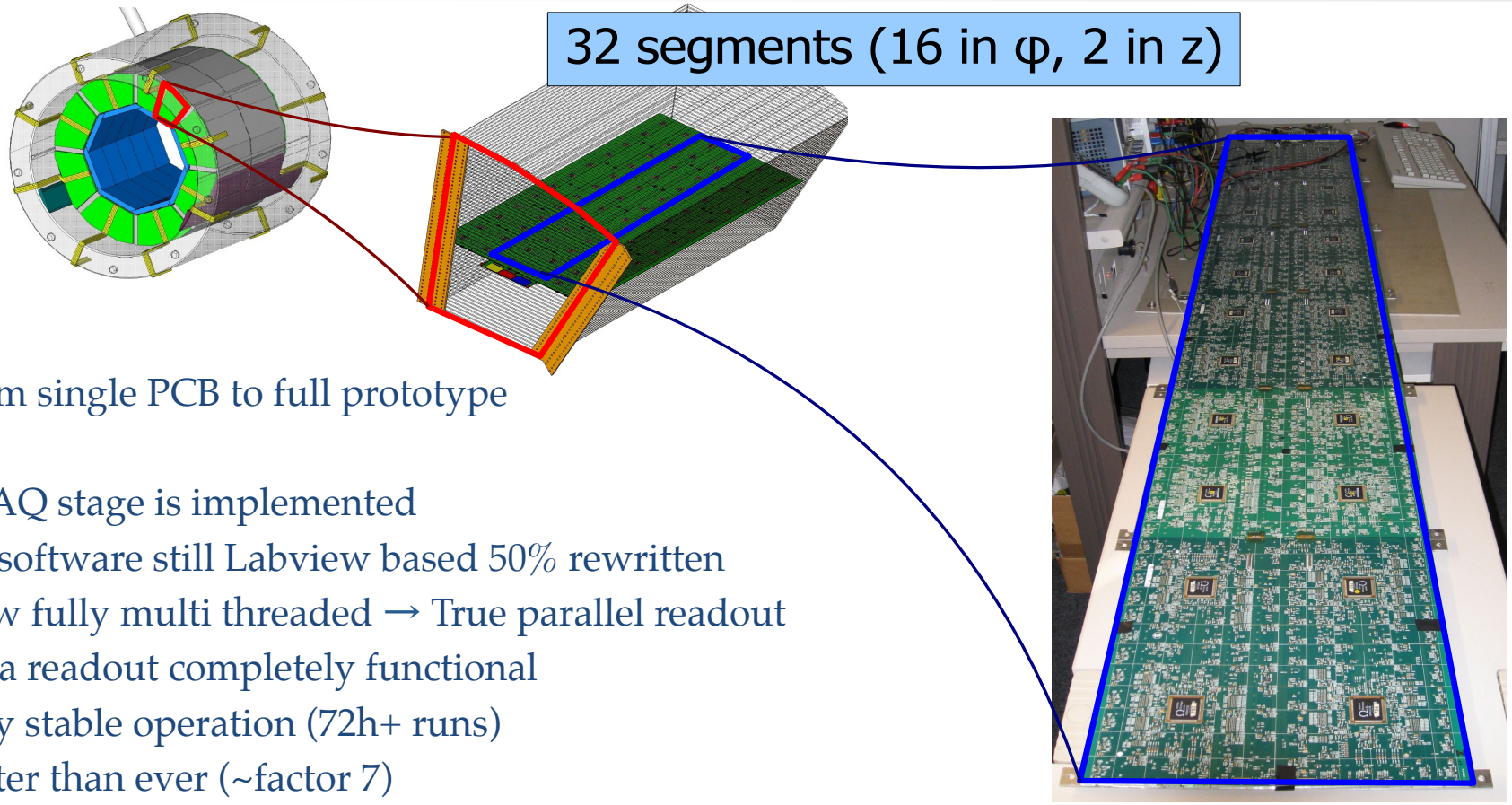
Prototype ASIC →

Luminosity calculation

- By parameterizing the Lorentz boost as a function of ISR, the measurements from LumiCal can be corrected.
  - Lost events are those where the boost is so large, that Bhabha events fall outside LumiCal detector.



AHCAL engineering prototype



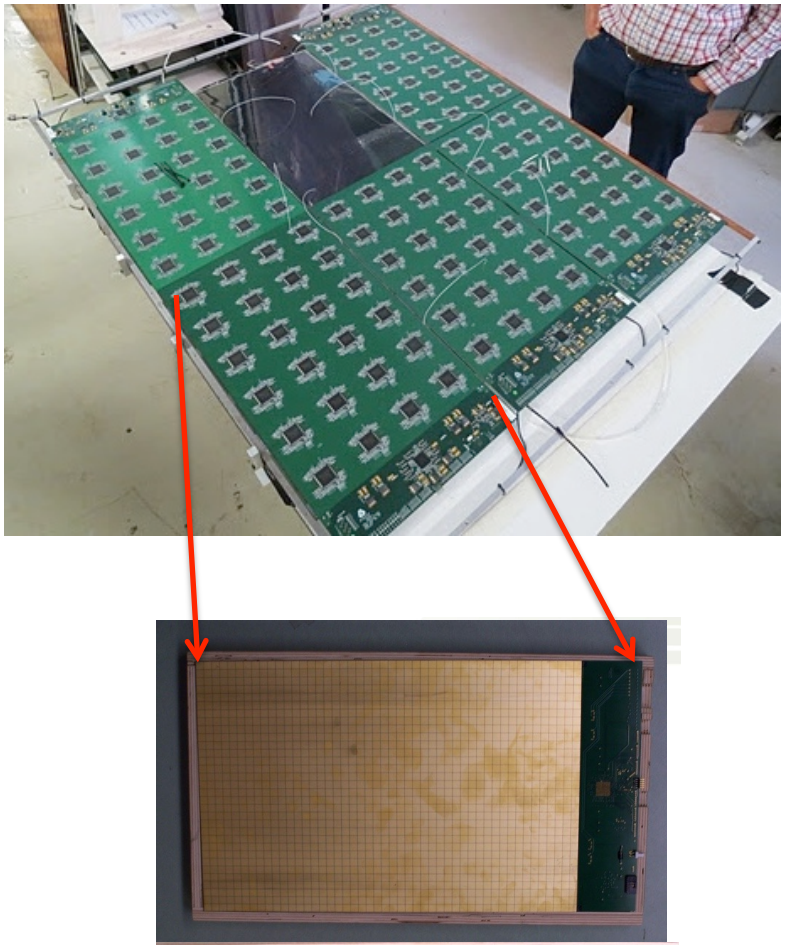
- From single PCB to full prototype

First DAQ stage is implemented

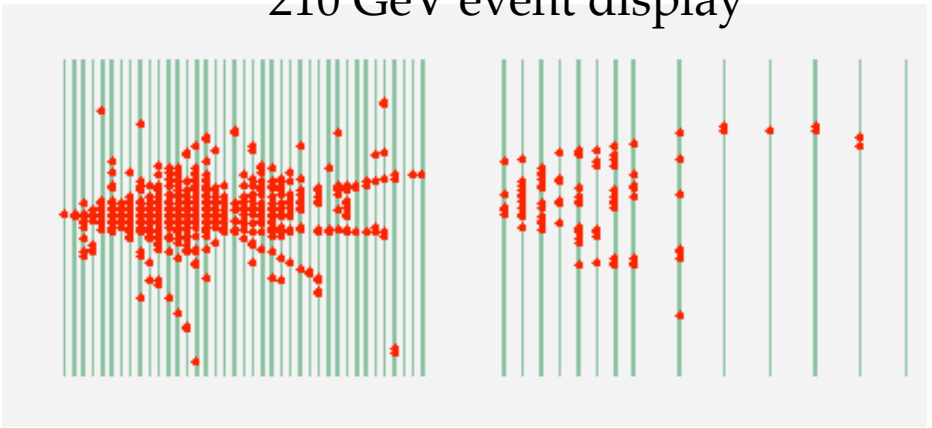
- PC software still Labview based 50% rewritten
- Now fully multi threaded → True parallel readout
- Data readout completely functional
- Very stable operation (72h+ runs)
- Faster than ever (~factor 7)
- Next step: establish parallel data path through LDA for testing

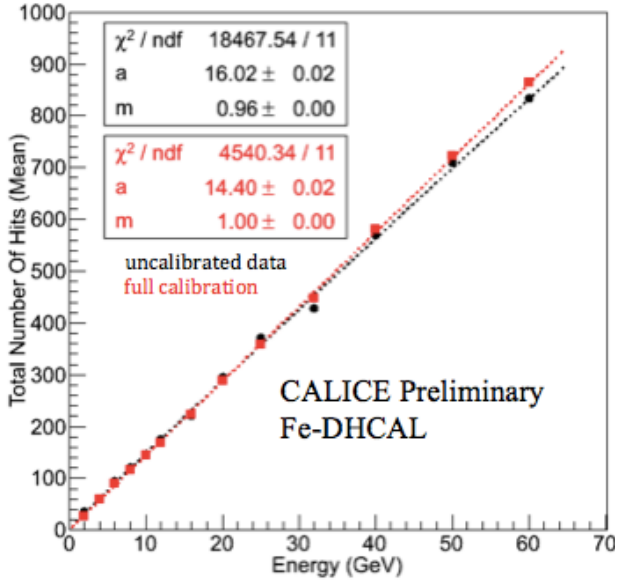
- Analysis software framework has been updated for the new prototype, including for example the timing information.

Digital HCAL with glass RPCs



210 GeV event display





- Smaller pads, no energy measurement per hit
- Calibration more difficult than anticipated, but now under control.